

## CLAIMS

What is claimed is:

1. A polynucleotide vaccine comprising a nucleic acid sequence encoding an antigen derived from a non-host species of a first phylum or first kingdom, wherein the nucleic acid sequence encoding the antigen is modified by deletion of a native signal sequence.
2. The polynucleotide vaccine of claim 1, wherein the nucleic acid sequence encoding the antigen is further modified to include a signal sequence derived from a second phylum or second kingdom, wherein the signal sequence is operably linked to the antigen-encoding sequence.
3. The polynucleotide vaccine of claim 2, wherein the signal sequence comprises a hemagglutinin A (HA) signal sequence.
4. The polynucleotide vaccine of claim 1, wherein at least one codon of the nucleic acid sequence encoding the antigen is modified from a wild type sequence of the non-host species to an analogous codon of a host species.
5. The polynucleotide vaccine of claim 1, further comprising a universal antigen or an immunogenic fragment thereof.
6. The polynucleotide vaccine of claim 1, wherein the first kingdom is plant.
7. The polynucleotide vaccine of claim 1, wherein the antigen is Amb a1.
8. The polynucleotide vaccine of claim 1, wherein the antigen is derived from a pathogen.
9. The polynucleotide vaccine of claim 8, wherein the pathogen is a bacterium, a virus or a parasite.

10. A method for modulating an immune response to an antigen comprising administering to a subject a polynucleotide vaccine of any one of claims 1-9 in an amount effective to modulate an immune response to the antigen.

11. The method of claim 10, further comprising administering to the subject an immunostimulatory nucleotide sequence (ISS).

12. The method of claim 10, wherein the antigen is an allergen.

13. The method of claim 12, wherein the allergen is a plant, food, latex, cat dander, cockroach or house dust mite allergen.

14. The method of claim 13, wherein the plant allergen is ragweed or grass pollen.

15. A method for eliciting an immune response to an antigen comprising administering to a subject a polynucleotide vaccine of any one of claims 1-9 in an amount effective to elicit an immune response to the antigen.

16. The method of claim 15, further comprising administering to the subject an immunostimulatory nucleotide sequence (ISS).

17. The method of claim 15, wherein the antigen is derived from a pathogen.

18. The method of claim 17, wherein the pathogen is a bacterium, a virus or a parasite.

19. The method of claim 11, wherein the ISS comprises an unmethylated 5'-CG-3' nucleotide sequence.

20. The method of claim 19, wherein the ISS comprises a sequence selected from the group consisting of: 5'-rrcgyy-3', 5'-rycgyy-3', 5'-rrcgyycg-3', 5'-rycgyycg-3' or 5'-(TCG)n-3'.

21. The method of claim 20, wherein the sequence is selected from the group consisting of: AACGTT, AGCGTT, GACGTT, GGCGTT, AACGTC, AGCGTC, GACGTC, GGCGTC, AACGCC, AGCGCC, GACGCC, GGCGCC, AACGCT, AGCGCT, GACGCT, GGCGCT, ATCGTT, ACCGTT, GTCGTT, GCCGTT, ATCGTC, ACCGTC, GTCGTC, GCCGTC, ATCGCT, ACCGCT, GTCGCT, GCCGCT, ATCGCC, ACCGCC, GTCGCC, GCCGCC, AACGTTCG, AGCGTTCG, GACGTTCG, GGCGTTCG, AACGTCCG, AGCGTCCG, GGCGTCCG, AACGCCCG, AGCGCCCG, GACGCCCG, GGCGCCCG, AACGCTCG, AGCGCTCG, GACGCTCG, GGCGCTCG, ATCGTTCG, ACCGTTCG, GTCGTTCG, GCCGTTCG, ATCGTCCG, ACCGTCCG, GTCGTCCG, GCCGTCCG, ATCGCTCG, ACCGCTCG, GTCGCTCG, GCCGCTCG, ATCGCCCG, ACCGCCCG, GTCGCCCG and GCCGCCCG.

22. A polynucleotide vaccine comprising a nucleic acid sequence encoding an Amb a1 allergen modified by deletion of a native Amb a1 signal sequence.

23. The polynucleotide vaccine of claim 22, wherein the nucleic acid sequence encoding the Amb a1 allergen is further modified to comprise a heterologous signal sequence operably linked to the Amb a1 allergen-encoding sequence.

24. The polynucleotide vaccine of claim 23, wherein the heterologous signal sequence comprises a hemagglutinin A (HA) signal sequence.

25. The polynucleotide vaccine of claim 22, wherein at least one codon of the nucleic acid sequence encoding the Amb a1 allergen is modified from a wild type sequence of the Amb a1 allergen to an analogous human codon.

26. A polynucleotide vaccine composition comprising:

a polynucleotide comprising a nucleic acid sequence encoding an antigen derived from a non-host species of a first phylum or first kingdom, wherein the nucleic acid sequence encoding the antigen is modified by deletion of a native signal sequence; and

an immunomodulatory nucleic acid molecule comprising the sequence 5'-cytosine-guanine-3'.

27. The polynucleotide vaccine composition of claim 26, wherein the nucleic acid sequence encoding the antigen is further modified to include a heterologous signal sequence derived from a second phylum or second kingdom, wherein the signal sequence is operably linked to the antigen-encoding sequence.

28. The polynucleotide vaccine composition of claim 27, wherein the heterologous signal sequence comprises a hemagglutinin A (HA) signal sequence.

29. The polynucleotide vaccine composition of claim 26, wherein at least one codon of the nucleic acid sequence encoding the antigen is modified from a wild type sequence of the non-host species to an analogous codon of a host species.

30. The polynucleotide vaccine composition of claim 26, wherein the antigen is Amb a1.

31. The polynucleotide vaccine composition of claim 26, wherein the immunomodulatory nucleic acid molecule comprises a sequence selected from the group consisting of 5'-rrcggy-3', 5'-rycggy-3', 5'-rrcggycg-3', 5'-rycggycg-3' or 5'-(TCG)n-3'.

32. The polynucleotide vaccine composition of claim 26, wherein the immunomodulatory nucleic acid molecule comprises a sequence selected from the group consisting of: AACGTT, AGCGTT, GACGTT, GGCGTT, AACGTC, AGCGTC, GACGTC, GGCGTC, AACGCC, AGCGCC, GACGCC, GGCGCC, AACGCT, AGCGCT, GACGCT, GGCGCT, ATCGTT, ACCGTT, GTCGTT, GCCGTT, ATCGTC, ACCGTC, GTGCGTC,

GCCGTC, ATCGCT, ACCGCT, GTCGCT, GCCGCT, ATCGCC, ACCGCC, GTCGCC,  
GCCGCC, AACGTTCG, AGCGTTCG, GACGTTCG, GGCGTTCG, AACGTCCG,  
AGCGTCCG, GACGTCCG, GGCGTCCG, AACGCCCG, AGCGCCCCG, GACGCCCG,  
GGCGCCCCG, AACGCTCG, AGCGCTCG, GACGCTCG, GGCGCTCG, ATCGTTCG,  
ACCGTTCG, GTCGTTCG, GCCGTTCG, ATCGTCCG, ACCGTCCG, GTCGTCCG,  
GCCGTCCG, ATCGCTCG, ACCGCTCG, GTCGCTCG, GCCGCTCG, ATCGCCCCG,  
ACCGCCCCG, GTCGCCCCG and GCCGCCCG.